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Composite Metal Article and Production Method Thereof

Technical Field

The present invention relates to a composite metal article and a production method thereof, and more particularly to a composite metal article in which carbon nanotubes are dispersed and a production method thereof.

Background Art

A composite metal article with carbon nanotubes dispersed in a metal has been proposed in JP-A-2000-223004.

In the case of producing this composite metal article, when metal particles having a diameter of 200 to 1000 nm are merely mixed with carbon nanotubes having a diameter of 5 to 20 nm, it is difficult to obtain a mixture in which both are uniformly mixed, because of a large difference of diameter therebetween.

For this reason, in the same patent document, the carbon nanotubes are added to and dispersed in an acid solution in which the metal particles have been dissolved, followed by drying and sintering, thereby obtaining the composite metal article.

The production method of the composite metal article proposed in this patent document has the disadvantages that a process thereof is extremely troublesome, that a long period of time is required, and that the production cost of the composite metal article becomes expensive.

In contrast with the production method of the composite metal article of such a patent document, the present applicant has proposed in the Shinano Mainichi Shimbun published on September 2, Heisei 15 (2003) that a modified

metal particle comprising carbon nanotubes and a metal such as copper with ends of the carbon nanotubes protruding in echinoid form, which is shown in Fig. 11, can be obtained by an electrolytic process using a metal ion-containing electrolytic solution in which the carbon nanotubes are dispersed with a special dispersing agent, and that a composite metal article excellent in heat radiation properties can be formed by thermopressing such modified metal particles.

Disclosure of the Invention

According to the technique proposed in the above-mentioned newspaper article by the present applicant, a composite metal article with carbon nanotubes dispersed in a metal can be easily obtained.

By the way, it is known that there are some metal particles (for example, copper particles) from which modified metal particles can be easily obtained by an electrolytic process and other metal particles (for example, aluminum particles and alloy particles) which are difficult to provide modified metal particles by an electrolytic process.

However, in the metals which are difficult to provide modified metal particles by an electrolytic process, there is a metal necessary in the case of intending weight saving of a structure and the like, such as aluminum.

Like this, even the composite metal article containing the metal which is difficult to provide modified metal particles by an electrolytic process can provide a composite metal article having various physical properties as well as excellent heat radiation properties, as long as carbon nanotubes can be dispersed in the composite metal article.

Then, an object of the invention is to provide a composite metal article with carbon nanotubes dispersed in the composite metal article containing a metal which is difficult to provide modified metal particles by an electrolytic process, and a production method thereof.

The present inventors have made a series of studies for achieving the above-mentioned object. As a result, it has been found that carbon nanotubes can be dispersed in a metal such as aluminum which is difficult to provide modified metal particles by an electrolytic process, by using modified metal particles obtained by an electrolytic process and modified with the carbon nanotubes which partially protrude outward from metal particles comprising copper or the like (hereinafter occasionally simply referred to as modified metal particles), thus completing the present invention.

That is to say, the present invention is a composite metal article characterized in that the composite metal article is formed by at least two kinds of metals, a first metal portion comprising one side of the above-mentioned two kinds of metals and a second metal portion comprising the other side of the above-mentioned two kinds of metals are formed at random, and carbon nanotubes are dispersed and incorporated in at least one side of the above-mentioned first metal portion and second metal portion.

In such a present invention, the carbon nanotubes are mixed through modified metal particles modified with the carbon nanotubes which partially protrude outward from metal particles comprising at least a metal of the one side of the metals which form the composite metal article, thereby being able to prevent separation between the carbon nanotubes and the metal particles, even when compression molding is performed.

As the modified metal particles, there can be suitably used modified metal particles obtained by an electrolytic process or an oxidation-reduction process.

Here, the modified metal particles by the electrolytic process can be obtained by passing an electric current between a cathode and an anode immersed in an electrolytic solution in which the carbon nanotubes are dispersed.

On the other hand, the modified metal particles by the

oxidation-reduction process can be obtained by an oxidation-reduction process of forming composite particles which contain the carbon nanotubes and comprise a metal salt or metal oxide slightly soluble in water, and then performing reduction treatment with a reducing agent which reduces the metal salt or metal oxide of the above-mentioned composite particles.

Further, the present invention is a production method of a composite metal article characterized in that when there is produced the composite metal article formed by at least two kinds of metals, wherein a first metal portion comprising one side of the above-mentioned two kinds of metals and a second metal portion comprising the other side of the above-mentioned two kinds of metals are formed at random, carbon nanotubes are mixed in at least one side of the above-mentioned first metal portion and second metal portion, using modified metal particles modified with the carbon nanotubes which partially protrude outward from the above-mentioned metal particles.

In such a present invention, the composite metal article in which the carbon nanotubes are dispersed can be obtained by compression molding the modified metal particles to form the first metal portion comprising a porous body, and then impregnating a molten metal obtained by melting the metal which forms the second metal portion in the above-mentioned porous body.

Here, by using as the molten metal a molten metal obtained by melting a metal which is difficult to provide modified metal particles by an electrolytic process, even the metal which is difficult to provide modified metal particles by an electrolytic process can easily disperse the carbon nanotubes.

Alternatively, the carbon nanotubes can also be easily dispersed in the metal by hot compression molding of modified metal particles comprising the metal which forms the first metal portion and metal particles comprising the metal which forms the second metal portion.

As such modified metal particles, there can be suitably used the modified metal particles obtained by the above-described electrolytic process

or oxidation-reduction process.

Brief Description of the Drawings

Fig. 1 is a schematic view for illustrating one example of a composite metal article relating to the present invention.

Fig. 2 is a schematic view for illustrating one example of a modified metal particle according used in the present invention.

Fig. 3 is a schematic view for illustrating another example of a modified metal particle used in the present invention.

Fig. 4 is a schematic view for illustrating a porous body obtained by compression molding modified metal particles.

Fig. 5 is an electron micrograph showing one example of a composite metal article relating to the present invention.

Fig. 6 is an electron micrograph showing one example of a modified metal particle used in the present invention.

Fig. 7 is an electron micrograph with respect to a cross section of a composite metal article obtained by using the modified metal particle shown in Fig. 6.

Fig. 8 is an electron micrograph with respect to a fractured surface of the composite metal article shown in Fig. 7.

Fig. 9 is an electron micrograph with respect to a cross section of another metal article obtained by using the modified metal particle shown in Fig. 6.

Fig. 10 is an electron micrograph with respect to a fractured surface of the composite metal article shown in Fig. 9.

Fig. 11 shows an electron micrograph of conventional modified metal particles.

Best Mode for Carrying Out the Invention

An outline of one example of a composite metal article relating to the

present invention is shown in Fig. 1. A composite metal article 10 shown in Fig. 1 comprises a first metal portion comprising a porous body formed by compression molding metal particles comprising a metal 12 to a specified form, and a second metal portion comprising a metal 14 which goes into pores of this porous body.

In the composite metal article 10 shown in this Fig. 1, carbon nanotubes 16, 16 ·· are dispersed in the porous body which forms the first metal portion comprising the metal 12. When the carbon nanotubes 16, 16 ·· coagulate and are unevenly distributed in the composite metal article 10, the physical properties such as the electric conductivity and thermal conductivity of the composite metal article 10 can not be sufficiently improved by mixing of the carbon nanotubes 16, 16 ··.

By the way, even when a mixture in which the metal particles comprising the metal 12, the metal particles comprising the metal 14 and the carbon nanotubes 16, 16 ·· are merely mixed is compression molded to a specified form, the carbon nanotubes 16, 16 ·· are easily separated from the metal particles during that process. This is because the particle size difference and the specific gravity difference between both are extremely large.

For this reason, when the composite metal article 10 shown in Fig. 1 is produced, at least one of a modified metal particle 18 shown in Fig. 2 and a modified metal particle 20 shown in Fig. 3 is used. The modified metal particle 18 shown in Fig. 2 is one in which an outer peripheral surface of a granular metal particle 22 is modified with the carbon nanotubes 16, 16 ·· partially protruding outward.

Further, The modified metal particle 20 shown in Fig. 3 is one in which an outer peripheral surface of a fibrous metal particle 24 is modified with the carbon nanotubes 16, 16 ·· partially protruding outward.

Such modified metal particles 18 and 20 shown in Figs. 2 and 3 can each be used alone, or both may be used together.

In such modified metal particles 18 and 20 shown in Figs. 2 and 3, each of the carbon nanotubes 16, 16 ·· are partially embedded in the metal particle 22 or the metal fiber 24, and the remainder protrudes outward from the metal particle 22 or the metal fiber 24.

Specifically, they are in a state where each base side is embedded in the metal particle 22 or the metal fiber 24 and a tip side protrudes, or in a state where both end sides thereof are embedded in the metal particle 22 or the metal fiber 24 and an intermediate portion is exposed, or in a state where both states coexist.

The carbon nanotube 16 used in such modified metal particles 18 and 20 may be either a monolayer or a multilayer, and one end or both ends thereof may be closed with a fullerene-like cap or cups.

Further, the carbon nanotube 16 has a tubular form in which the length thereof is 100 times or more the diameter.

As this carbon nanotube 16, it is preferred to use one having a diameter of several nanometers to several hundred nanometers (for example, 300 nm) or less.

In the case of the carbon nanotube 16 having a diameter of less than 15 nm, the electric conductivity decreases in some cases. In the carbon nanotube 16 having a diameter of less than 15 nm, when two integers which determine the chiral vector for specifying a spiral direction of a crystal structure thereof, n and m (chiral index), are multiples of n-m=3 or n=m, the electric conductivity occurs.

On the other hand, the carbon nanotube 16 having a diameter of 15 nm or more shows the electric conductivity, even when the chiral index is other than the above-mentioned conditions.

Such a carbon nanotube 16 has no anisotropy in electric conductivity like graphite, and the current flows in all directions on a surface.

For this reason, in the modified metal particles 18 and 20 whose outer

peripheral surfaces are modified with the carbon nanotubes 16, the carbon nanotubes 16 come into contact with each other or with other metal particles at surface layer planes thereof. Accordingly, what is necessary is just to be one in which at least an outermost layer (contact layer) of the metal particle 22 or metal fiber 24 is modified with the carbon nanotubes 16.

Further, the metal particle 22 or metal fiber 24 modified with the carbon nanotubes 16 may be one comprising a metal easily modified with the carbon nanotubes 16, for example, copper.

The shape of the metal particle 22 may be aspherical or flaky, as well as spherical, and is not limited.

In order to obtain the composite metal article 10 having an internal structure shown in Fig. 1, at least one of the modified metal particles 18 and 20 shown in Fig. 2 and Fig. 3 is first produced.

Each of the modified metal particles 18 and 20 shown in Fig. 2 and Fig. 3 can be obtained by applying the current between a cathode and an anode inserted in an electrolytic solution in which the carbon nanotubes 16, 16 ·· have been dispersed, thereby conduct electrolysis, and electrolytically depositing metal particles (metal powder) containing the modified metal particles 18 and 20, on a surface of the cathode.

Such modified metal particles 18 and 20 can be easily obtained, when there are used the modified metal particles 18 and 20 comprising a metal which is easily deposited by an electrolytic method, for example, copper.

In contrast, compared to the modified metal particles 18 and 20 comprising copper, it is difficult to obtain the modified metal particles 18 and 20 comprising aluminum by electrolysis under ordinary conditions. Further, it is also difficult to obtain the modified metal particles 18 and 20 comprising an alloy by electrolysis under ordinary conditions, as a rule.

In this manner, at least one of the granular modified metal particle 18, 18 ·· and the fibrous modified metal particle 20, 20 ·· obtained by the

electrolytic method are compression molded to obtain the porous body. This porous body may be further baked as needed.

In such a compression molding process, the carbon nanotubes 16, 16 ·· are also partially embedded in the metal particle 22 or the metal fiber 24. Accordingly, even when the force of compression molding or the like is applied, separation between the metal particle 22 or the metal fiber 24 and the carbon nanotubes 16, 16 ·· can be prevented.

An outline of the porous body 30 obtained by compression molding the modified metal particles 18, 18 ·· shown in Fig. 2 is shown in Fig. 4. In the resulting porous body 30, the modified metal particles 18, 18 ·· come into contact with one another, and pores 32, 32 ·· are formed among the modified metal particles 18, 18 ··. The carbon nanotubes 16, 16 ·· are entangled with one another, and go into this pore 32.

Then, the porous body 30 having an internal structure shown in Fig. 4 is immersed in a molten metal obtained by melting a metal different from the metal which forms the granular modified metal particle 18, and the molten metal is impregnated in the pores 32, 32 ·· in the porous body 30. In this case, it is preferred that the porous body 30 is immersed in the molten metal while aspirating under vacuum or pressurizing, thereby forcedly impregnating the molten metal in the porous body 30.

After that, the porous body 30 impregnated with the molten metal is taken out of the molten metal and cooled, thereby being able to obtain the composite metal article 10 shown in Fig. 1.

The second metal portion comprising the metal 14 of the composite metal article 10 shown in Fig. 1 is one formed by cooling the molten metal filled in each of the pores 32, 32 ·· of the porous body 30, the first metal portion.

The carbon nanotubes 16, 16 ·· are entangled with one another, and go into each of such pores 32, 32 ··, and the carbon nanotubes 16, 16 ·· are also

dispersed in the second metal portion comprising the metal 14.

For this reason, for example, the porous body 30 which is the first metal portion is formed, using the metal particles 22 comprising copper which easily forms the modified metal particles 18, by the modified metal particles 18 in which the outer peripheral surfaces of the metal particles 22 are modified with the carbon nanotubes 16, 16 ··, and then molten aluminum is impregnated in the porous body 30, thereby being able to obtain the composite metal article 10 in which the first metal portion comprising copper as the metal 12 and the second metal portion comprising aluminum as the metal 14 are formed at random, and the carbon nanotubes 16, 16 ·· are dispersed in the first metal portion.

The porous body 30 as the first metal portion shown in Fig. 4 is one obtained by compression molding the granular modified metal particles 18, 18 ··. However, it can also be obtained by compression molding the fibrous modified metal particles 20, 20 ··.

As the production method of the composite metal article 10 shown in Fig. 1, there has hitherto been described the production method of impregnating the porous body 30 which forms the first metal portion obtained by compression molding the granular or fibrous modified metal particles 18 or 20 in which the metal particles 22 or metal fibers 24 comprising the metal 12 are modified with the carbon nanotubes 16, 16 ··, with the molten metal obtained by melting the metal 14 which forms the second metal portion. However, it can also be obtained by adding at least one of the granular modified metal particle 18 and fibrous modified metal particle 20 which form the first metal portion to the molten metal obtained by melting the metal 14 which forms the second metal portion, followed by kneading.

Further, at least one of the granular modified metal particle 18 and the fibrous modified metal particle 20 comprising the metal 12 which forms the first metal portion are mixed with the metal particle comprising the metal 14

which forms the second metal portion, and then, compression molded to a formed article of a specified form, which is heated to melt the metal particles comprising the metal 14, thereby also being able to obtain the composite metal article 10 shown in Fig. 1. In this case, the melting point of the metal 14 is preferably lower than that of the metal 12 which forms the modified metal particles 18 and 20.

Further, as production methods of the granular modified metal particles 18 or the fibrous modified metal particles 20, various production methods can be employed in addition to the electrolytic method.

For example, they can be obtained by scattering the carbon nanotubes 16, 16 ·· in a nonoxidative atmosphere, and granulating or fibrillating and injecting the molten metal into this nonoxidative atmosphere with a piezoelectric pump, thereby adhering and fixing the carbon nanotubes 16 to the surfaces of the metal particles 22 or the metal fibers 24.

Furthermore, they can also be formed by crushing, granulating or fibrillating the molten metal in which the carbon nanotubes 16, 16 ·· are dispersed by kneading.

Alternatively, the granular modified metal particles 18 or the fibrous modified metal particles 20 can also be obtained by an oxidation-reduction process of forming composite particles which contain the carbon nanotubes 16, 16 ·· and comprise a metal salt or metal oxide slightly soluble in water, and then, reducing deposited composite particles with a reducing agent which reduces the above-mentioned metal salt or metal oxide.

Specifically, the granular modified metal particles 18 or the fibrous modified metal particles 20 can be obtained by dissolving a water-soluble metal salt in an aqueous solution in which the carbon nanotubes 16, 16 ·· have been dispersed, thereafter, adding to the aqueous solution an alkali which reacts with a metal ion dissolved in this aqueous solution to produce a metal salt or metal oxide slightly soluble in water, while dispersing the carbon nanotubes 16,

16 ··, thereby depositing composite particles which contain the carbon nanotubes 16, 16 ·· and comprise the metal salt or metal oxide slightly soluble in water, and then, reducing the deposited composite particles with a reducing agent which reduces the metal salt or metal oxide.

In this oxidation-reduction process, dispersion of the carbon nanotubes 16, 16 ·· can also be performed by giving a shock to the aqueous solution by an ultrasonic wave, or by adding a dispersing agent with stirring the aqueous solution by mechanical stirring according to a stirrer or the like. This dispersing agent may be any, as long as it is a surfactant which can disperse the carbon nanotubes 16, 16 ··. The surfactants include octylphenoxypolyethoxyethanol, sodium dodecylsulfate and polyacrylic acid.

In order to perform more easily such dispersion of the carbon nanotubes 16, 16 ··, it is preferred to give a shock by an ultrasonic wave to the aqueous solution to which the above-mentioned dispersing agent has been added.

Further, as the water-soluble metal salt, there can be suitably used a water-soluble metal salt comprising copper, nickel or silver, and more preferably, there can be used a sulfate, a nitrate, or an acetate comprising copper, nickel or silver.

The fine composite particles comprising the metal salt or metal oxide slightly soluble in water, which has been thus obtained, are substantially spherical, and composite particles containing the carbon nanotubes 16, 16 ·· having a particle size of 1 μm or less.

Further, such composite particles are formed in the aqueous solution in which the carbon nanotubes 16, 16 ·· are dispersed, the carbon nanotubes 16, 16 ·· dispersed in the aqueous solution can be taken in the composite particles in the course of forming the composite particles, and the carbon nanotubes 16, 16 ·· are contained in the formed composite particles in a uniformly dispersed state.

Then, the resulting composite particles are reduced with the reducing agent which reduces the metal salt or metal oxide slightly soluble in water, thereby being able to obtain the granular modified metal particles 18 or the fibrous modified metal particles 20.

As such a reducing agent, there can be used one or two or more kinds of the group consisting of hydrazine, a hydrazine compound, formalin, acetaldehyde, formic acid, rochelle salt, hydroxylamine, glucose and hydrogen peroxide. This reducing agent may be added to the aqueous solution in which the composite particles comprising the metal salt or the metal oxide are precipitated, or may be brought into direct contact with the composite particles comprising the metal salt or the metal oxide, which has been separated from the aqueous solution, thereby reducing the metal salt or the metal oxide

When foaming occurs by the reduction reaction due to the reducing agent added to the aqueous solution or by the surfactant added to the aqueous solution, an antifoaming agent such as an alcohol may be added.

According to these production methods of the modified metal particles 18 and 20, even the metal 14 which is difficult to obtain the metal particles 18 and 20 by an electrolytic process can provide the metal particles 18 and 20.

For this reason, at least one of the granular modified metal particle 18 and the fibrous modified metal particle 20 comprising the metal 12 which forms the first metal portion is mixed with the metal particle comprising the metal 14 which forms the second metal portion, and then, compression molded, thereby being able to obtain the composite metal article 10 shown in Fig. 1. Also in this case, baking may be performed after the compression molding as needed.

Using the composite metal article 10 shown in Fig. 1, which has hitherto been described, only the metal 12 which forms the modified metal particles 18 and 20 may be removed by chemically dissolving or melting it to form the composite metal article with the carbon nanotubes 16, 16 ·· dispersed

in the metal 14

Further, the composite metal article from which the metal 12 has been removed may be impregnated with a molten metal comprising the metal 14, or may be impregnated with a molten metal comprising another kind of metal.

Furthermore, in place of the composite metal article 10 shown in Fig. 1, the composite metal article of the invention may be a composite metal article in which spaces among the second metal portions comprising the metal 14 are filled with the first metal portions comprising the metal 12 with the carbon nanotubes 16, 16 ·· dispersed.

Such a composite metal article can be obtained by mixing the metal particle comprising the metal 14 with at least one of the granular modified metal particle 18 and the fibrous modified metal particle 20, and performing hot compression molding.

After the metal particle comprising the metal 14 are mixed with at least one of the granular modified metal particle 18 and the fibrous modified metal particle 20, compression molding is performed, and baking may be further performed.

(Example 1)

An electric current is passed between a cathode and an anode inserted in an electrolytic solution in which carbon nanotubes 16, 16 ·· having a diameter of 200 nm are dispersed to conduct electrolysis, thereby electrolytically depositing copper particles on a surface of the cathode. According to an electron micrograph for the copper particles, there were obtained modified metal particles 18 modified with the carbon nanotubes 16, 16 ·· which partially protrude outward from the copper particles 22, as shown in Fig. 2.

The metal particles comprising the modified metal particles 18 are compression molded to obtain a formed article of a specified form. When a

cross section of this formed article was observed under a microscope, it was a porous body in which a number of pores were formed, as shown in Fig. 4.

The resulting formed article was immersed in molten aluminum maintained at 750°C for about 1 hour while aspirating under vacuum, thereby forcedly impregnating the molten metal in the formed article.

Then, the formed article taken out of molten aluminum was cooled to obtain a composite metal article comprising copper, aluminum and the carbon nanotubes. When a cross section of this composite metal article was observed under a microscope, second metal portions comprising aluminum were randomly formed in a first metal portion comprising the porous body formed by copper, as shown in Fig. 1.

According to an electron micrograph shown in Fig. 5 for a cross section of this composite metal article, the carbon nanotubes (indicated by arrows) were dispersed in copper and aluminum.

(Example 2)

(1) Production of Modified Metal Particles 18

Carbon nanotubes (VGCF manufactured by Showa Denko K.K.) (0.36 g), 100 g of water and 0.4 g of octylphenoxypolyethoxyethanol [trade name: TRITON X-100 (manufactured by ICN Biomedical, Inc.)] were subjected to dispersion treatment by means of an ultrasonic homogenizer (VC-750 manufactured by Ultra Sonic, Inc.), and then, 28 g of nickel chloride ($NiCl_2$) was put in, followed by heating up to 50°C while stirring with a stirrer to obtain a dispersion.

Further, an alkali solution obtained by adding 13 g of sodium hydroxide ($NaOH$) to 50 g of pure water was prepared.

Then, the alkali solution was added to the resulting dispersion while stirring by giving an ultrasonic wave with an ultrasonic washing machine [US-1 manufactured by As One Co., Ltd.] and with a glass rod. The

dispersion became a deposition solution in which composite particles were deposited.

While heating this deposition solution up to 60°C and stirring with a stirrer, 64 g of a hydrazine hydrate ($N_2H_4 \cdot H_2O$) as a reducing agent was added to conduct a reduction reaction. In that case, 100 g of ethanol was added depending on a state of foaming, and the reduction reaction was terminated. After the reduction reaction was terminated, the deposition solution was cooled to ordinary temperature, and a precipitate was collected, followed by washing and drying under vacuum.

The resulting composite particles were nickel colored, nickel metal particles containing 5% by weight of the carbon nanotubes, and granular modified metal particles in which one end portion of the carbon nanotube protruded outward from the granular metal particle, as indicated by arrows in Fig. 6.

(2) Production of Composite Metal Article

After the resulting granular modified metal particles were mixed with an atomized copper powder, the mixture was kept at a temperature of 500°C for 1 hour while pressurizing it, and molded to a specified form. The amount of this atomized copper powder mixed was adjusted so that the atomized copper powder in a baked article became 60% by weight.

The resulting baked article was one in which a first metal portion comprising nickel filled as a binder around a second metal portion comprising the atomized copper powder, as shown in a micrograph of a cross section of Fig. 7.

In a nickel portion of a fractured surface of such a baked article, carbon nanotubes were dispersed, as indicated by arrows in an electron micrograph of Fig. 8.

(Example 3)

After the modified metal particles obtained in Example 2, which comprise the carbon nanotubes and nickel, were mixed with a tungsten powder, the mixture was kept at a temperature of 500°C for 2 hours while pressurizing it, thereby performing baking. The amount of this tungsten powder mixed was adjusted so that the tungsten powder in a baked article became 55% by volume.

The resulting baked article was one in which a first metal portion comprising nickel filled as a binder around a second metal portion comprising the tungsten powder, as shown in a micrograph of a cross section of Fig. 9.

In a nickel portion of a fractured surface of such a baked article, carbon nanotubes were dispersed, as indicated by arrows in an electron micrograph of Fig. 10.

Industrial Applicability

Even when a mixture in which metal particles of plural species are merely mixed with carbon nanotubes is compression molded to a specified form, the carbon nanotubes coagulate to be easily separated from the metal particles during that process. It is therefore extremely difficult to obtain a composite metal article with the carbon nanotubes dispersed in the metal article comprising metals of plural species.

In this regard, according to the present invention, when there is produced a composite metal article formed by at least two kinds of metals, wherein a first metal portion comprising one side of the above-mentioned two kinds of metals and a second metal portion comprising the other side of the above-mentioned two kinds of metals are formed at random, carbon nanotubes can be mixed in at least one side of the first metal portion and second metal portion without separation of the carbon nanotubes during the production process of the composite metal, by using modified metal particles which are metal particles

comprising at least one metal of the two kinds of metals and modified with the carbon nanotubes which partially protrude outward from the metal particles.

These first metal portion and second metal portion are formed at random in the composite metal article, so that according to the present invention which can mix the carbon nanotubes in at least one side of such first metal portion and second metal portion, there can be obtained the composite metal article in which the carbon nanotubes are dispersed.